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The drivers of illegal wildlife activities in Moyowosi game reserve

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Abstract

Illegal wildlife activity poses a serious danger to the fragile ecological balance of Moyowosi Game Reserve, which is primarily a marsh surrounded by pristine wilderness. This paper comprehensively examined the drivers of illegal wildlife activities occurring in the reserve. Data were gathered from 383 respondents through household questionnaires across ten proximal, systematically selected villages in Kigoma. Most of the respondents were of the age between 18-40 from south sampling location n=148(79.14%). The analysis revealed that the major drivers of illegal wildlife activities, based on strong agreement among respondents, were subsistence-based n=236 (61.62%), commercial based n=214 (55.87%), and insufficient land for grazing n=190 (49.61%). These findings were derived from a total sample size of 383 respondents for each driver, with varying levels of agreement including agree, undecided, disagree, and strongly disagree. However, insufficient land for agriculture, waterbodies for fishing, source of fuelwood, crop yield, high market value, increase of foreigners and influence of refugees and illegal immigrants are other identified drivers of illegal activities. Further, the result showed that, the highly committed illegal wildlife activities in Moyowosi Game Reserve are poaching n=199(51.96%), illegal fishing n=196(51.17%) and illegal grazing n=166(43.34%). Among other strategies, this paper recommends increased community involvement, enforcement efforts, increased use of technology like drones in patrols, encourage the youth to establish groups and offering micro-credit loans to establish small businesses. Furthermore, this study recommends increasing conservation education and awareness campaigns within communities, including school children. It also suggests that the government should consider locating refugee camps far from protected areas in the future and emphasize village land use planning.

Keywords: *Conservation; Drivers of illegal wildlife activities; Moyowosi Game Reserve*

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Introduction

The rise of unlawful activities in protected areas has created a serious threat to ecological balance, exposing the world to the perils of climate change, -ecological degradation, and other sorts of environmental problems (Ibanga, 2017; Kideghesho, 2016; Wilfred, 2015; Mrosso *et al.*, 2022). They also pose a serious threat to world biodiversity as well as social and economic development. It is also regarded as a main mechanism of global overexploitation, contributing to the extinction of a number of species (Hitchens and Blakeslee, 2020; Gluszek *et al.*, 2021).

Illegal exploitation of natural resources remains a big issue for several countries. Between 1970 and 1989, around 700,000 African elephants were slain, accounting for roughly half of the continent's loxodonta resources; this may have been done to supply the world market for ivory (Ibanga, 2017).

Illegal wildlife activity is recognized as a security and humanitarian concern in addition to causing ecological and financial difficulties (Abotsi *et al.*, 2002). It has been shown to finance political unrest and terrorism in Africa (Maguire and Haenlein, 2015). Intimate relationships to their natural environment characterize many African rural communities, who depend on biodiversity for their livelihoods, customs, and cultural activities (Kideghesho, 2016). When these ecosystems are disrupted, poverty and social instability may worsen and have a knock-on effect on community well-being (Becker *et al.*, 2013).

It is estimated that roughly 40% of al-Shabaab's income comes from trafficking and harvesting ivory that is found in Northern Kenya (Duffy, 2016). Thousands of wild animals in the DRC's Garamba National Park have been decimated, and the destruction is believed to have been caused by rebels in the DRC and Uganda's Lord Resistance Army (LRA) (Marais, *et al*., 2019. Large-scale poaching of terrestrial large mammals is driven by organized crime networks, while the pet trade and trophy hunting pose a threat to gorillas and lions (Harrison, 2011; Laurance *et al*., 2012). The most trafficked mammal, pangolins, suffer for their meat and scales.

Between the 1970s and 1980s, Tanzania saw a disastrous decade of unlawful activities such as elephant massacre (Alden and Harvey, 2021; Kideghesho, 2016). The increase in unlawful activities mirrors the period since independence, with the most notable harming elephants, rhinos, and pangolins in the 1970s, 1980s, and 2014. Illegal wildlife activities caused a catastrophic reduction in elephant and rhino populations, with the elephant population dropping by more than 30% from 203,000 in 1977 to 57,334 in 1991, and only 275 rhinos survived in 1992 compared to 3,795 in 1981, a loss of more than 93% of the population (Kideghesho, 2016). Tanzania wildlife products are primarily consumed in Asian countries, including China, as in other African countries (Alden and Harvey, 2021). The black market's favorite wildlife products include elephant ivory, rhino horn, and pangolin scales (Alden and Harvey, 2021).

So far, both national and international authorities have been unable to prevent illegal resource extraction, which amounts for an estimated 15-30% of worldwide wood commerce and 50-90% of tropical timber harvests (Schaafsma *et al*., 2014). Many emerging economies rely on the export of forestry products (Ibanga, 2017). Illegal harvesting for timber is a major issue in Tanzania, affecting all protected areas (Kideghesho, *et al*., 2006; Wilfred, 2015).

A number of wild species threatened by poaching in protected areas lack population trend analyses, raising the likelihood that losses would escape unnoticed by organizations in charge of administering protected areas (Rija, 2017). Undiscovered trafficking routes influence criminal activity trends, which must be disseminated in order to capture and halt illegal activities (Ibanga, 2017). Wildlife trafficking entails smuggling from the source country into the transit or destination country (Haken, 2011). They sometimes use smuggling channels for contraband items and illegal substances in the process. For example, According to (UNODC, 2022), ivory was poached in Zambia and Mozambique, smuggled to Malawi by road, and then processed in a factory and kept in warehouses for purchasers and further shipping to China, Hong Kong, Japan, and Singapore. Some ivory is processed in Africa and sold in retail stores, where individual layers from Asia bring it home in their luggage. In 2009, Kenyan officials intercepted 300kg of ivory packed in coffins on a flight from Mozambique to the Lao People's Democratic Republic (UNODC, 2022). Elephant ivory, rhino horn, pangolin scales, and timber are among the most trafficked wildlife products (Ibanga, 2017; Mrosso *et al*., 2022).

Rija (2017) predicted a substantial likelihood of giraffe and buffalo population decreases in the Serengeti National Park due to unlawful activities. Although it is commonly accepted that socioeconomic and cultural factors drive demand, wildlife species are still illegally traded

for a variety of purposes (Hitchens and Blakeslee, 2020) including food and commercial (Mrosso *et al*., 2022). Understanding information on illegal actions is critical since it varies regionally and over time, and there is a need to forecast future patterns for probable future management methods (Rija, 2017). Despite the efforts of law enforcement, illicit activities continue to be a problem in protected regions (Kakira, 2010). Ranger-collected data are critical in giving critical information that can aid in the suppression of illicit activity (Wilfred, 2015).

Moyowosi Game Reserve's extensive wetland nature, remoteness, and inaccessibility make it difficult to manage, and its proximity to politically unstable countries adds to the pressure (primarily from illegal immigrants) of indiscriminate grazing and illegal natural resource harvesting; as a result, illegal livestock grazing is prevalent in the Moyowosi Game Reserve (Musika *et al*., 2022). Illegal grazing has increased in Moyowosi Game Reserve during the last 30 years and according to the 2014 aerial census, cattle numbers inside Moyowosi Game Reserve exceeded 50,000 heads, but buffalo numbers were only 2,869 heads *(*Musika *et al*., 2022). The four hunting blocks that hunters left behind have not only remained particularly vulnerable to poaching and subsequent livestock intrusions, but they have also jeopardized economic gains for local communities and the Tanzanian economy (Musika *et al*., 2022).

The main objective of this study was to assess the underlying factors that drive people to engage in illegal activities in Moyowosi Game Reserve. The specific objectives were: 1) to assess the socio-demographic characteristics of respondents from the ten study villages (Nchitatu, Itumbiko, Kumhasha, Kumbanga, Kumshindwi, Busunzu, Nyarulanga, Muvinza, Kagerankanda, and Chagu), and 2) to examine the drivers of illegal activities in Moyowosi Game Reserve. The study was guided by two questions: 1) What are the socio-demographic characteristics of the respondents in the study villages? and 2) What are the underlying factors that drive people to engage in illegal activities in Moyowosi Game Reserve?

According to Hariohay *et al*., (2019), similar studies have not been conducted in the Ugalla-Moyowosi Game Reserve, but rather in the Serengeti, Tarangire, Katavi, and Ruaha-Rungwa ecosystems. Therefore, assessing the factors driving illegal activities in Moyowosi Game Reserve is crucial for suggesting possible conservation measures for this and other protected areas within the Ugalla-Moyowosi Ecosystem.

Materials and Methods

Study area

Moyowosi Game Reserve is situated in northwest Tanzania, between latitudes 3^{o} 15' to 5^{o} 00' S and longitudes 30^{o} 30' to 32^{o} 00' E. The elevation varies between 800 and 1600 meters above sea level. Moyowosi Game Reserve in combination of Uvinza open area, Makere North and South forest reserves, Ugalla Game Reserve, Igombe Game Reserve, Ugalla River, and Kigosi National Parks forms the Malagarasi-Moyovozi Ramsar site which covers 30% of Lake Tanganyika's total watershed area (Musika *et al*., 2022). Like some other protected areas in Tanzania, the reserve was previously inhabited by humans who were then relocated (Musika *et al.*, 2021) following its gazettement in 1981, with GN No. 1 covering an area of 11430 km^{2} (Ngilangwa, 2015) and is currently managed by the Tanzania Wildlife Management Authority (TAWA).

The reserve is part of the Ugalla Moyowosi Ecosystem and is mostly located in Kibondo and Kakonko Districts in Kigoma Region. The two districts of Kibondo and Kakonko have borders with the politically unstable countries of Burundi and Rwanda, causing tension and illicit activity (Musika *et al*., 2021). The reserve is additionally bounded in the east by Kigosi National Park, in the west by North and South Makere Forest Reserves in Kasulu District, and in the north by Kibondo, Kakonko, and Biharamulo Districts. Currently, there are two operational refugee camps: Nduta in Kibondo District and Nyarugusu Refugee Camp in Kasulu District (Musika *et al*., 2022; Ngilangwa, 2015). The other refugee camps of Mtabila-Kasulu, Lugufu-Uvinza, Mtendeli, Karago-Kakonko, Kanembwa, and Mkugwa-Kibondo have been closed, and the most of the refugees were returned to Burundi and the Democratic Republic of the Congo, with a few remaining relocated to existing refugee camps such as Nyarugusu (Schwartz, 2019). The

trends driving illegal activities in the reserve are most likely driven by indigenous people, but also by illegal immigrants from neighboring countries and the influence of the existing refugee camps.

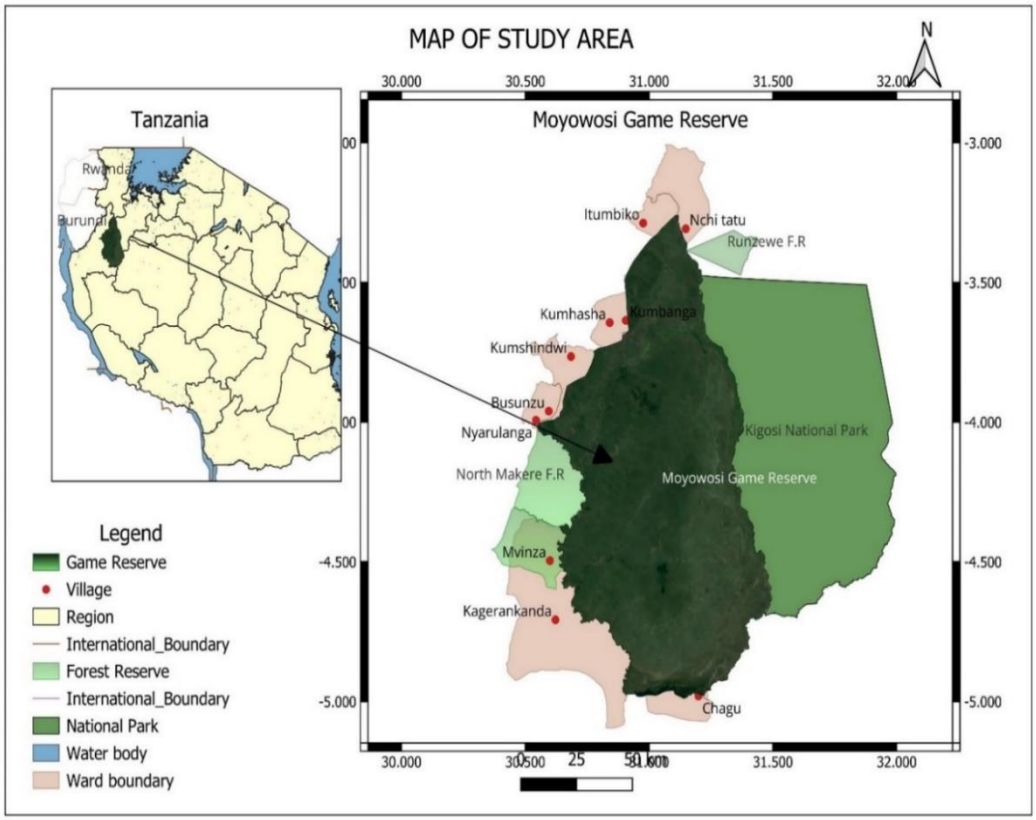
Data collection

A Semi-structured with both open and closed-ended questions and structured questionnaires were used to collect the data from the 383 selected respondents (adult men and women of 18 years and above) for a period of two months (February-March 2024).

Two conservation rangers were trained to administer the questionnaire to the illegal entrants (on face-to-face administered questionnaires), due to the confidential protocol and nature of law enforcement of handling suspects immediately after the time of arrest (Hariohay, Ranke, Fyumagwa, Kideghesho and Røskaft, 2019). Additional methods of ten focused groups with ten people (men and women), key informants (3 Conservation Officers, 6 Conservation rangers) and 2 illegal entrants. A snowball sampling method was used to select 5 confidential informants who have lived with the illegal entrants in their communities, some have once been involved in illegal wildlife activities while some are still doing illegal wildlife activities.

Figure 1

Map showing the location of Moyowosi Game Reserve and the study villages



This study strictly adhered to research ethics by obtaining necessary permits from the University of Dodoma and approvals from various Tanzanian authorities, including Tanzania Commission for Science and Technology (COSTECH), the Tanzania Wildlife Management

Authority (TAWA), the President's Office Regional Administration and Local Government (PO-RALG), and the Regional Administrative Secretary of Kigoma Region. The respondents were requested for their consents before the interview were conducted. Therefore, the information used in this article is the one which comes from the respondents who were willing to volunteer information during the interview. The personal information such as names and address of respondents (villagers, key informants, illegal entrants and confidential informants) were kept anonymous.

Table 1

Sample size in the study villages

S/N	District	Ward	Village	Sapling location/site	Total Population	Household	Sample size
1	Biharamulo	Kalenge	Nchitatu	North	3300	550	16
2	Kakonko	Kakonko	Itumbiko	North	3903	841	19
		Murungu	Kumhasha	West	10214	2042	40
			Kumbanga	West	2594	509	13
3	Kibondo	Busagara	Kumshindwi	West	9120	1520	45
		Busunzu	Busunzu	West	8319	1721	41
			Nyarulanga	West	4445	794	22
4	Kasulu	Kagerankanda	Muvinza	South	12263	2420	60
			Kagerankanda	South	20136	3826	99
5	Uvinza	Mtego wa Noti	Chagu	South	5736	1041	28
					80030	**15264**	**383**

Survey Monkey (2023); NBS (2022)

Data analysis

Data were organized in an excel, coded and cleaned by using SPSS version 26 analytical software and then imported in the STATA ver. 16 software for descriptive and statistical analysis. Prior to data analysis, the data were tested for normality by Shapiro-Wilk test and appeared not normal ($p>0.05$. Descriptive statistics was done to show the distribution of illegal activities and the drivers by reporting using frequency and percentages. Chi-square ($\chi 2$) and Kruskal-Wallis (H) tests were used to analyze the variation of response on illegal activities across the variables against the sampling locations.

The data being non-parametric, a Chi-square ($\chi 2$) and Kruskal-Wallis (H) tests were used to analyze the variation of responses and means of independent variables on illegal activities and across the three categorized sampling locations/sites of North (n=35), South (n=187) and West (n=161) defined as North=Nchi tatu and Itumbiko, West= Kumhasha, Kumbanga, Kumshindwi, Busunzu and Nyarulanga while South= Mvinza, Kagerankanda and Chagu.

Results

Social demographics characteristics of the respondents (N=383)

The result indicates that there were more respondents of the age between 18-40 toping all age groups with many of them coming from south sampling location n=148 (79.14%) and west sampling location n=91(56.52%). The age group 0f between 41-60 and that of >60 had more respondents in the west sampling locations n=52(32.30%) and 18(11.18%) respectively (Table 2). The variation in age group across the sampling locations/sites was significant (Chi-square ($\chi 2$) =31.2671, $P<0.05$).

It was crucial to interview male and female respondents of at least eighteen years old and above to determine who specifically had a

stronger grasp of illegal wildlife activities. This helps to acquiring comprehensive data regarding the respondent age groups for thorough comprehension of the ways in which varying age relate to the perception and knowledge of illicit wildlife activities.

Gender results indicate a significant gender gap, with men making up n=135 (72.19% in the south and n=30 (85.71%) in the north sampling locations (n=234). The females made up n=92(57.14%) in the west sampling location (Table 2). The variation in gender across the sampling locations/sites was significant (Chi-square (χ2) =41.14, P<0.05). This variation implies that men contribute more information relevant to the study's assessment of drivers of illegal activities.in Moyowosi Game Reserve. The focus on gender representation is a result of a strong desire to comprehend how different genders contribute differently to our understanding of illegal wildlife activities.

Table 2
Socio demographic profile of the respondents

Variable	Category	Sampling location/site			χ2	p-value
		North n=35(%)	South n=187(%)	West n=161(%)		
Gender	Female	5(14.29)	52(27.81)	92(57.14)	41.14	0.001
	Male	30(85.71)	135(72.19)	69(42.86)		
Age	18-40	15(42.86)	148(79.14)	91(56.52)	31.26	0.001
	41-60	17(48.57)	32(17.11)	52(32.30)		
	>60	3(8.57)	7(3.74)	18(11.18)		

Key: North=Nchi tatu and Itumbiko
West= Kumhasha, Kumbanga, Kumshindwi, Busunzu and Nyarulanga,
South= Mvinza, Kagerankanda and Chagu

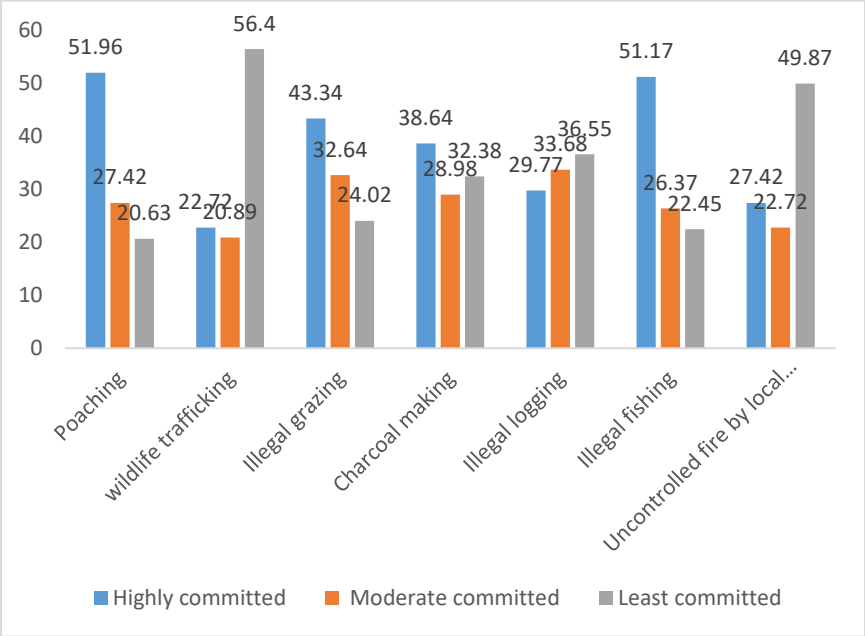
General perception of local communities on illegal activities in Moyowosi Game Reserve
The result indicates that, the highly committed illegal wildlife activities in Moyowosi Game Reserve are poaching n=199 (51.96%), illegal fishing n=196 (51.17%) and illegal grazing n=166 (43.34%). Charcoal making n=124 (32.38%) and illegal logging n=140 (36.55%) were moderately committed while the least committed illegal wildlife activities are wildlife trafficking n=216 (56.40%) and uncontrolled fire by local communities n=191(49.87%). The variations of responses across the variables was not significant (H =2.06, P>0.16) (Figure2).

Perception of local communities on illegal activities across sampling locations/sites in Moyowaosi Game Reserve
The result indicates that, poaching was highly committed in the south sampling location n=123 (65.78%) followed by the west sampling location n=58(36.02%). It was moderately committed n= 62(38.51%) in the west sampling location and least committed n=2(5.71%) in the north sampling location. The variation in poaching across the sampling locations/sites was significant (Chi-square (χ2) =41.3437, P<0.05). Illegal fishing was highly committed in the south sampling location n=96(51.34%), moderately committed in the west sampling location n=50(31.06%) and least committed in the north sampling location n=1(2.86%). The variation in illegal fishing across the sampling locations/sites was significant (Chi-square (χ2) =14.14, P<0.05). Illegal grazing was highly committed in the west sampling location n=79(49.07%) followed by south sampling location n=69(36.90%) moderately committed in the west sampling

location n=62(38.51%) and least committed in the north sampling location n=1(2.86%).

Figure 2

General perception of local communities on illegal wildlife activities in Moyowosi Game Reserve in percentage (N=383).



The variation in Illegal grazing across the sampling locations/sites was significant (Chi-square ($\chi 2$) =40.9844, P<0.05). Charcoal making was highly committed in the south sampling location n=75(40.11%) moderately committed in the west sampling location n=71(44.10%) and least committed in the north sampling location n=2(5.71%). The variation in Charcoal making across the sampling locations/sites was significant (Chi-square ($\chi 2$) =37.49, P<0.05). Illegal logging was highly and moderately committed in the west sampling location n=59(36.65%) and n=65(40.37%) was least committed in the south sampling location n=102(54.55%). The variation in illegal logging across the sampling locations/sites was significant (Chi-square =56.37, P<0.05). Wildlife trafficking was highly and moderately committed in the west n=38(23.60%) and n=37(22.98%) while it was least committed in the south sampling location 119(63.64%). The variation in wildlife trafficking across the sampling locations/sites was significant (Chi-square ($\chi 2$) =14.10, P<0.05). Uncontrolled fire by local communities was highly and moderately committed in the west sampling location n=54(33.54%), n=54(33.54%), and was least committed in the south sampling location 135(72.19). The variation in Uncontrolled fire by local communities across the sampling locations/sites was significant (Chi-square =82.66, P<0.05).

Table 3

Perception of local communities on illegal activities across sampling locations/sites in Moyowosi Game Reserve

Illegal activities	level of agreement	sampling site			$\chi 2$	p-value
		North n=35(%)	South n=187(%)	West n=161(%)		
Poaching	Highly committed	18(51.43)	123(65.78)	58(36.02)	41.34	0.001
	Moderate committed	15(42.86)	28(14.97)	62(38.51)		
	Least committed	2(5.71)	36(19.25)	41(25.47)		
wildlife trafficking	Highly committed	14(4.00)	35(18.72)	38(23.60)	14.10	0.007
	Moderate committed	10(28.57)	33(17.65)	37(22.98)		
	Least committed	11(31.43)	119(63.64)	86(53.42)		
Illegal grazing	Highly committed	18(51.43)	69(36.90)	79(49.07)	40.98	0.001
	Moderate committed	16(45.71)	47(25.13)	62(38.51)		
	Least committed	1(2.86)	71(37.97)	20(12.42)		
Charcoal making	Highly committed	17(48.57)	75(40.11)	56(34.78)	37.49	0.001
	Moderate committed	16(45.71)	37(19.79)	71(44.10)		
	Least committed	2(5.71)	75(40.11)	34(21.12)		
Illegal logging	Highly committed	17(48.57)	38(20.32)	59(36.65)	56.37	0.001
	Moderate committed	17(48.57)	47(25.13)	65(40.37)		
	Least committed	1(2.86)	102(54.55)	37(22.98)		
Illegal fishing	Highly committed	22(62.86)	96(51.34)	78(48.45)	14.14	0.007
	Moderate committed	12(34.29)	39(20.86)	50(31.06)		
	Least committed	1(2.86)	52(27.81)	33(20.50)		
Uncontrolled fire by local communities	Highly committed	20(57.14)	31(16.58)	54(33.54)	82.66	0.001
	Moderate committed	12(34.29)	21(11.23)	54(33.54)		
	Least committed	3(8.57)	135(72.19)	53(32.92)		

Key: North=Nchi tatu and Itumbiko
West= Kumhasha, Kumbanga, Kumshindwi, Busunzu and Nyarulanga,

South= Mvinza, Kagerankanda and Chagu

Table 4

General perception of local communities on the underlying factors that drive people to engage in illegal activities in Moyowosi Game Reserve

Variable	level of agreement N=383 (%)					Statistics	
	Strongly agree	**Agree**	**Undecided**	**Disagree**	**Strongly disagree**	**H**	**p-value**
Commercial based	214(55.87)	66(17.23)	5(1.31)	4(1.04)	94(24.54)	11.96	<0.00
Subsistence based	236(61.62)	51(13.32)	16(4.18)	3(0.78)	77(20.10)		
Insufficient land for grazing	190(49.61)	104(27.15)	14(3.66)	17(4.44)	58(15.14)		
Insufficient land for agriculture	33(8.62)	165(43.08)	41(10.70)	14(3.66)	130(33.94)		
Insufficient waterbodies for fishing	54(14.10)	84(21.93)	9(2.35)	16(4.18)	220(57.44)		
Insufficient source of wood for fuel	32(8.36)	116(30.29)	35(9.14)	46(12.01)	154(40.21)		
Insufficient yield	38(9.92)	43(11.23)	44(11.49)	35(9.14)	223(58.22)		
High market value	38(9.92)	43(11.23)	35(9.14)	38(9.92)	223(58.22)		
Increase of foreigners	58(15.14)	44(11.49)	27(7.05)	20(5.22)	234(61.10)		
Influence of refugees and illegal immigrants	32(8.36)	36(9.40)	27(7.05)	24(6.27)	264(68.93)		

Key: H = Kruskal wallis
P = P-value

General perception of local communities on the underlying factors that drive people to engage in illegal activities in Moyowosi Game Reserve

The result indicates that, the level of agreement for illegal wildlife activities in Moyowosi Game Reserve that drive people to engage in illegal activities was strongly agree for subsistence-based n=236(61.62%) followed by commercial based n=214 (55.87%) and insufficient land for grazing n=190(49.61%). The level of agreement for illegal wildlife activities was agree for insufficient land for agriculture n=165(43.08%) and insufficient source of wood for fuel n=116(30.29%).

The level of agreement was strongly disagreeing as a driver of illegal activities for influence of refugees and illegal immigrants n=264(68.93%), increase of foreigners n=234(61.10%), high market 223(58.22%), insufficient yield n=223(58.22%), insufficient areas for fishing n=220(57.44%) and insufficient source of fuelwood n=154(40.21%). The variation of responses across the variables was significant (H =11.96, P<0.05) (table 4).

Perception of local communities on the underlying factors that drive people to engage in illegal activities across the sampling location/sites in Moyowosi Game Reserve

Subsistence based was strongly agreed in the south sampling location n=120(64.17%) and strongly disagreed in the west sampling location n=44(27.33%). The variation in subsistence based as a driving factor for illegal wildlife activities across the sampling locations/sites was significant (Chi-square (χ2) =20.28, P<0.05). Insufficient land for grazing was strongly agreed in the south sampling location n=100 (53.48%) and strongly disagreed in west sampling location n=37(19.79%). The variation for insufficient land for grazing as a driving factor for illegal wildlife activities across the sampling locations/sites was significant (Chi-square (χ2) =75.61 P<0.05). Commercial based was strongly agreed in the south sampling location n=124 (66.31%) and strongly disagreed in west sampling location n=78 (48.45%). The variation for commercial based as a driver for illegal wildlife activities across the sampling locations/sites was significant (Chi-square (χ2) =92.72, P<0.05). Insufficient land for agriculture was agreed in the west sampling location n=97(60.25%) and strongly disagreed in the south sampling location n=85(45.45%). The variation in for insufficient land for agriculture as a driving factor for illegal wildlife activities across the sampling locations/sites was significant (Chi-square (χ2) =68.31, P<0.05).

Insufficient waterbodies for fishing were agreed in the west sampling location n=47(29.19%) and strongly disagreed in the south sampling location n=106(56.68%). The variation in for insufficient areas for fishing as a driving factor for illegal wildlife activities across the sampling locations/sites was significant (Chi-square (χ2) =22.05, P<0.05). Insufficient source of fuelwood was agreed in the west sampling location n=76(47.2%) and strongly disagreed in the south sampling location n=85(45.45%). The variation in for insufficient source of wood for fuel as a driving factor for illegal wildlife activities across the sampling locations/sites was significant (Chi-square (χ2) =77.54, P<0.05)). Insufficient yield was agreed in the south sampling location n=29(15.51%) and strongly disagreed in the west sampling location n=114(70.81%). The variation in for insufficient yield as a driving factor for illegal wildlife activities across the sampling locations/sites was significant (Chi-square (χ2) =50.38, P<0.05).

High market value was agreed in the south sampling location n=43(22.99%) and strongly disagreed in the west sampling location n=116(72.05%). The variation in for High market value as a driving factor for illegal wildlife activities across the sampling locations/sites was significant (Chi-square (χ2) =50.97, P<0.05). Increase of foreigners was strongly agreed in the south sampling location n=45(24.06%) and strongly disagreed in the west sampling location n=124(77.02). The variation for increase of foreigners as a driving factor for illegal wildlife activities across the sampling locations/sites was significant (Chi-square (χ2) =58.53, P<0.05). Influence of refugees and illegal immigrants was strongly agreed in the west sampling location n=134(83.23) and strongly disagreed in the south sampling location n=97(51.87%). The variation for increase of foreigners as a driving factor for illegal wildlife activities across the sampling locations/sites was significant (Chi-square (χ2) =56.00, P<0.05).

Table 5

Perception of local communities on the underlying factors that drive people to engage in illegal activities across the sampling location/sites in Moyowosi Game Reserve

Drivers	level of agreement	Sampling location/ sites			$\chi 2$	p-value
		North n=35(%)	South n=187(%)	West n=161(%)		
Commercial based	Strongly agree	24(68.57)	124(66.31)	66(40.99)	92.72	0.001
	Agree	7(20.00)	42(22.46)	17(10.56)		
	Undecided	0(0.00)	5(2.67)	0(0.00)		
	Disagree	0(0.00)	4(2.14)	0(0.00)		
	Strongly disagree	4(11.43)	12(6.42)	78(48.45)		
Subsistence based	Strongly agree	29(82.86)	120(64.17)	87(54.04)	20.28	0.009
	Agree	1(2.86)	25(13.37)	25(15.53)		
	Undecided	0(0,00)	12(6.42)	4(2.48)		
	Disagree	0(0.00)	2(1.07)	1(0.62)		
	Strongly disagree	5(14.29)	28(14.97)	44(27.33)		
Insufficient land for grazing	Strongly agree	1(2.86)	100(53.48)	89(55.28)	75.61	0.001
	Agree	25(71.43)	27(14.44)	52(32.30)		
	Undecided	0(0.00)	11(5.88)	3(1.86)		
	Disagree	0(0.00)	12(6.42)	5(3.11)		
	Strongly disagree	9(25.71)	12(7.49)	37(19.79)		
Insufficient land for agriculture	Strongly agree	1(2.86)	25(13.37)	7(4.35)	68.31	0.001
	Agree	26(74.29)	42(22.46)	97(60.25)		
	Undecided	1(2.86)	25(13.37)	15(9.32)		
	Disagree	0(0).00	10(5.35)	4(2.48)		
	Strongly disagree	7(20.00)	85(45.45)	38(23.60)		
Insufficient water bodies for fishing	Strongly agree	2(5.71)	36(19.25)	16(9.94)	22.05	0.005
	Agree	8(22.86)	29(15.51)	47(29.19)		
	Undecided	0(0.00)	4(2.14)	5(3.11)		
	Disagree	0(0.00)	12(6.42)	4(2.48)		

	Strongly disagree	25(71.43)	106(56.68)	89(55.28)		
Insufficient source of fuelwood	Strongly agree	1(2.86)	24(12.83)	7(4.35)	77.54	0.001
	Agree	20(57.14)	20(10.70)	76(47.20)		
	Undecided	0(0.00)	24(12.83)	11(6.83)		
	Disagree	1(2.86)	34(18.18)	11(6.83)		
	Strongly disagree	13(37.14)	85(45.45)	56(34.78)		
Insufficient yield	Strongly agree	0(0.00)	29(15.51)	9(5.59)	50.38	0.001
	Agree	3(8.57)	23(12.30)	17(10.50)		
	Undecided	1(2.86)	31(16.58)	12(7.45)		
	Disagree	0(0.00)	26(13.90)	9(5.59)		
	Strongly disagree	31(88.57)	78(41.71)	114(70.81)		
High market value	Strongly agree	1(2.86)	26(13.90)	9(5.59)	50.97	0.001
	Agree	3(8.57)	43(22.99)	23(14.29)		
	Undecided	0(0.00)	27(14.44)	9(5.59)		
	Disagree	0(0.00)	14(7.49)	4(2.48)		
	Strongly disagree	31(88.57)	77(41.18)	116(72.05)		
Increase of foreigners	Strongly agree	0(0.00)	45(24.06)	13(8.07)	58.53	0.001
	Agree	2(5.71)	30(16.04)	12(7.45)		
	Undecided	2(5.71)	18(9.63)	7(4.35)		
	Disagree	0(0.00)	15(8.02)	5(3.11)		
	Strongly disagree	31(88.57)	79(42.25)	124(77.02)		
Influence of refugees and illegal immigrants	Strongly agree	0(0.00)	27(14.44)	134(83.23)	56.00	0.001
	Agree	1(2.86)	23(12.30)	12(7.45)		
	Undecided	1(2.86)	19(10.16)	7(4.35)		
	Disagree	0(0.00)	21(11.23)	3(1.86)		
	Strongly disagree	33(94.24)	97(51.87)	5(3.11)		

Key: North=Nchi tatu and Itumbiko
West= Kumhasha, Kumbanga, Kumshindwi, Busunzu and Nyarulanga,
South= Mvinza, Kagerankanda and Chagu

Discussion

Even though Illegal wildlife activities are often a result of multiple intersecting factors, our findings in this article indicated that, the prominent drivers of illegal wildlife activities in Moyowosi Game Reserve are subsistence based, insufficient land for grazing and commercial based. People engage in illegal wildlife activities driven by the need to secure basic necessities, generate income, and sustain livestock amidst limited resources and economic pressures.

Subsistence based

The study revealed that bushmeat remains a dominant source of subsistence, indicating that communities around Moyowosi Game Reserve still rely on it to meet their dietary needs. A study by (Lyakurwa and Sabuhoro, 2024) conducted adjacent Mkomazi National Park (MNP) supports this finding, noting that food security is the primary driver of illegal activities in the park. A confidential informant from the south sampling location mentioned that motorbikes transporting wildlife products, including bushmeat and fish, from the reserve staring around 10:00 PM are common. This observation aligns with (Nyahongo *et al*., 2021), who reported similar activities in the western Serengeti National Park (SNP).

A study by (Nuno *et al*., 2013) also found that bushmeat is widely consumed by local communities surrounding protected areas in the Serengeti, where hunting is conducted both for subsistence and to generate cash. However, through group discussions and a key informant, it was noted that hunting for bushmeat and illegal fishing in Moyowosi Game Reserve still persist, although at a lower level compared to the period from 2013 to 2022.

Despite the south sampling location having Lake Nyamagoma, which is partly within the reserve and partly in public areas, people prefer hunting and fishing in the reserve due to overutilization of public water bodies. Illegal fishing also occurs in Lake Kabale in the north sampling location for both subsistence and commercial purposes. In the west, which is far from water bodies, people use the western part of the reserve for bushmeat hunting. Dudley *et al*. (2018) supports this study, stating that domestic subsistence needs are often the driving forces behind illegal bushmeat hunting. People often overlook the long-term consequences of exploiting natural resources carelessly (Duffy and St John, 2013; Von Essen *et al*., 2014; Kideghesho, 2016).

This challenge of illegal bushmeat harvesting has led to a decline in wild animal populations in many protected areas in the tropics, particularly in East and Southern Africa (Ihwagi *et al*., 2015). In this context, (Hariohay *et al*., 2019) assessed the drivers of conservation crimes in the Rungwa-Kizigo-Muhesi Game Reserves, Central Tanzania, and found that poverty complicates conservation efforts. Addressing this issue requires promoting conservation through the sustainable use of resources, both directly and indirectly.

Commercial based

The study found that commercial motivations play a significant role in the communities around Moyowosi Game Reserve, as the trade in wildlife products can be highly lucrative and offers a significant source of income. A study by (Cooney *et al*., 2017) supports these findings, indicating that poaching motivations within communities include the need to meet subsistence needs and the desire to improve financial well-being or social standing.

"A confidential informant mentioned that due to commercial poaching, elephants can now be found far from the park boundary, as most were hunted for their ivory when the refugee camps of Mtabila-Kasulu, Lugufu-Uvinza, Mtendeli, Karago-Kakonko, Kanembwa, and Mkugwa-Kibondo were active. Consequently, elephant poaching incidents were rare during this study, though they still occur". The south sampling location is also prone to illegal firearm trafficking

used in poaching, while the west sampling location was reported to be involved in logging, bushmeat hunting, and charcoal production. This finding is supported by (Uddin *et al*., 2023), who found that the risks associated with firearm possession by poachers contributed to the decline of the tiger population in Sundarbans National Park, West Bengal, India. Hariohay *et al*. (2019) also highlighted that illegal activities often cater to commercial interests by targeting valuable species, such as elephants for their ivory.

"Current poaching in Moyowosi Game Reserve involves animals such as buffalo, hippos, and fish for both commercial and subsistence purposes as per Group discussions, Key and Confidential informants". Nuno *et al*. (2013) estimated that 8-57% of households in the western Serengeti engage in bushmeat hunting. The study also revealed a significant decline in illegal wildlife activities compared to the period from 2013 to 2022. Reported markets for these activities are within the communities and towns such as Usinge, Nguruka, Kigoma, Uvinza, Kasulu, Kibondo, and Kakonko, and sometimes across the country's border to Burundi, from where products are flown to Europe and the Far East in Asian countries (MNRT, 2014).

Logs and charcoal are sold as far away as Mwanza, Arusha, Dodoma, and Dar es Salaam. Over 80% of Tanzania's urban and peri-urban population relies on charcoal, primarily sourced from Miombo woodlands, as their primary energy source. This consumption significantly contributes to deforestation, forest degradation, and greenhouse gas emissions (Lulandala *et al*., 2023; Nyamoga *et al*., 2022; Sakala *et al*., 2023; Schaafsma *et al*., 2014) highlighted that illegal logging fuels social unrest, undermines livelihoods, feeds corruption, denies governments funding, and depletes a nation's natural resource base.

Insufficient land for grazing

The study revealed that, insufficient land for grazing forces herders to encroach and use Moyowosi Game Reserve for grazing especially in the southern part of the reserve unlike the west. The south sampling location was revealed to have higher number of livestock than the west and the north where most of the agricultural land during the rainy season is cultivated and the rest is reserved by the government as Forest and Game Reserves where grazing areas become scarce forcing them to use the reserve for pasture. The findings are supported by (Ruvuga, 2021) who found that the shrinking of open rangelands used for grazing has led to utilization of Miombo woodlands as alternative grazing resource in Kilosa-Morogoro. ''A confidential informant in the north sampling location also said, livestock are in the reserve and motorcycles ferry milk outside the reserve''. However, ''a key informant, said even though, illegal grazing still exists, herds of livestock in the reserve have declined significantly due to interventions made by the government''.

Grazing in Moyowosi Game Reserve ranges from a few meters to far deeper within the reserve as also observed by (Musika *et al*., 2021). As the rainy season approaches, grazers take advantage by moving their cattle deeper into the reserve. However, when most of the reserve becomes flooded, it becomes challenging to withdraw the cattle therefore complicating the situation. Additionally, the flooding hinders rangers' vehicle patrols, making it difficult to monitor and enforce regulations effectively. The study is supported by (Musika *et al*., 2022) who highlighted the challenges faced in balancing livestock needs and conservation efforts, especially during the rainy. Musika *et al*., (2022) further noted that, illegal grazing intensified over the past 30 years in Moyowosi Game Reserve, and the 2014 aerial census showed that livestock numbers inside Moyowosi Game Reserve were more than 50,000 heads while buffalo numbers were only 2,869 heads. Musika *et al*. 2021) noted that, intrusions were reported in the southern region, but they may have recently spread to other areas. This study, not only in the south, also found intrusions in north sampling locations of the reserve. Dudley *et al*. (2018) pointed out that, the availability of pasture and water resources in protected areas (PAs) is what motivates illegal livestock grazing because there is insufficient or deteriorating grazing space outside of Protected areas as with the case of Moyowosi Game Reserve.

Insufficient land for agriculture

Insufficient agricultural land was also identified as a driving factor for illegal wildlife activities.

While the south sampling location had adequate agricultural land, the west sampling location faced a specific need for more land, likely due to population growth forcing encroachment into protected areas for agricultural conversion and settlement, as observed by (Hariohay *et al*., 2019) in communities adjacent to Rungwa, Muhesi, and Kizigo Game Reserves. Despite the west's lack of sufficient agricultural land, the study revealed that agricultural land and yields were still adequate to meet the community's needs. This indicates that while land scarcity is a localized issue, overall agricultural productivity is sufficient. This suggests that other factors, such as subsistence hunting, unemployment, and grazing needs, may be more influential in driving human activities in the reserve. Musika *et al.* (2021) noted that communities near the Moyowosi Game Reserve have limited access to traditional employment and primarily engage in agriculture and other risky activities like pastoralism and beekeeping.

Insufficient waterbodies for fishing

This study revealed significant variations in the availability of water bodies for fishing as a driving factor in illegal activities. Despite this, the south sampling location had adequate water bodies for fishing, being the confluence of the Malagarasi, Moyowosi, Nikonga, Kigosi, and Gombe rivers that form the Malagarasi basin. However, the water bodies outside the reserve, including Lake Nyamagoma, are overfished, forcing people to use the water bodies within the reserve. These findings are supported by Peterson and Stead, (2011), who noted that in the Western Indian Ocean, illegal fishing and a lack of enforcement of fishing regulations are among the top threats to coastal resources due to overfishing in public water bodies.

The west sampling location lacks the water bodies present in the south and north, leading to less involvement in illegal fishing, as people from the west must travel long distances to find water bodies for fishing. Overfishing outside the reserve puts additional pressure on the reserve, highlighting the need for better management and alternative livelihood strategies to reduce illegal fishing within the reserve. Musika *et al*., (2021) also pointed out that illegal fishing is driven by the need for income and food subsistence.

Additionally, the reserve is part of the Malagarasi-Moyowosi Ramsar site, making it wet and impassable year-round, which could be suitable for fishing (Musika *et al*., 2022; Musika *et al*., 2021; Ngilangwa, 2015). Natasha and Minnaar, (2022) highlighted that Africa's exponential population growth has led to increased waste production, food demand, and employment needs, posing significant threats to aquatic life. Telesetsky, (2014) added that illegal, unreported, and unregulated (IUU) fishing practices, driven by financial gain, exploit weak management systems and corrupt administrations.

Insufficient source of fuelwood

The variations of response across the sampling locations for insufficient source of fuelwood as a driving factor for illegal wildlife activities in Moyowosi Game Reserve was significant. This study revealed that, the west sampling site is congested and highly populated leading into high demand of charcoal and firewood. This fact is supported by (Mapesa *et al*., 2013; Kasangaki *et al*., 2012) through the study conducted in Virunga in the DRC Congo which found that Alternative energy to charcoal for domestic cooking within the Great Virunga Landscape (GVL) and beyond was not yet practically possible with the majority of people dependent on charcoal and firewood.

The public lands in the west sampling location is mostly cleared for agricultural farms and settlements for the communities and therefore run shortage of sources of fuelwood. The south and the north sampling locations have satisfactory public lands which are used for fuelwood. This deforestation has generally led to a shortage of fuelwood, pushing local communities to engage in illegal activities within the reserve to meet their energy needs. Caro, (1999) and Dudley *et al*., (2018) found out that, due to being closer to the protected area, Sukuma at Mpimbwe collect firewood in the Mlele North Game Controlled Area. Addressing these threats is essential to ensure the conservation and sustainable management of Africa's forests and

the vital ecosystem services they provide (Musika *et al.*, 2021).

Insufficient crop yield

Despite significant variations in responses across the sampling locations, insufficient crop yields were identified as a driving factor for illegal wildlife activities. However, generally, the communities adjacent to Moyowosi Game Reserve have satisfactory yields, although climate change may have impacted the consistency of rainfall and overall production. Musika *et al*. (2021) noted that these communities face similar climate challenges as elsewhere, due to anthropogenic activities linked to human and livestock population growth. This suggests that some individuals may engage in illegal wildlife activities to meet their needs.

Overall, climate change has posed significant threats to smallholder, subsistence, and pastoral systems, leading to frequent droughts and floods. Poaching, as well as crop and livestock production, serve to fulfill needs for energy, clothing, health, cash income, and direct food requirements (Morton, 2007). This indicates a need for a more comprehensive approach to address these underlying causes.

High market value

The study found that the high market value of wildlife products influences people to engage in illegal wildlife activities to meet their needs, making wildlife one of the most lucrative sources of criminal income (Haken, 2011). Key markets for illegal wildlife products, such as bushmeat, tree logs, ivory, and fish, were reported in locations including Usinge, Nguruka, Kigoma, Uvinza, Kasulu, Kibondo, Mwanza, Dodoma, Dar es Salaam, and Burundi. The profitability of these markets drives community members to exploit wildlife resources despite the risks and legal consequences, underscoring the need for targeted interventions to curb illegal trade and provide alternative livelihoods.

(Kideghesho *et al.* 2006) complements this by noting that elephant poaching often escalates due to local community support for wealthy commercial poachers, as the returns from poaching far exceed those from legal economic activities, making it a crucial livelihood and coping strategy for poor communities.

The study revealed that most illegal wildlife trade occurs in the south more than in the west and north, possibly due to the influence of immigrants. Ibanga, (2017) pointed out that the wildlife market is substantial. Therefore, combating organized crime in the illegal wildlife trade is crucial for the global community because of the environmental and social problems resulting from organized criminal participation in the trade (Zimmerman, 2003).

Increase of foreigners

The increase in the number of foreigners, particularly in the south sampling location, has significantly impacted the reserve, with many of these individuals coming from Burundi. A study by Ndijuye and Tandika, (2022) found that there was an influx of foreigners in western Tanzania, with over 300,000 out of the three million refugees being naturalized as citizens. When foreigners settle near the reserve, they become familiar with the area and often engage in illegal wildlife activities to meet various socio-economic demands. These individuals are known to use both civilian and military weapons for poaching, posing a serious threat to wildlife populations and complicating enforcement efforts due to the increased risk and sophistication of their operations, as observed by Uddin (*et al*., 2023) in Sundarbans National Park in India. Resolving the issue of foreign involvement in illegal activities will require a multifaceted strategy that addresses both conservation efforts and the humanitarian concerns of refugee and immigrant populations.

Influence of refugees and illegal immigrants

The influence of refugees and illegal immigrants in the west sampling location has been significantly detrimental to the reserve. Masalu, (2008) found similar impacts in Burigi and Kimisi Game Reserves, now Burigi Chato and Kimisi National Parks, between October 2006 and January 2007. The study revealed that refugee activities, including farming, settlements, poaching, bush fires, tree cutting, grazing, and encroachment, severely impacted the area, leading to a significant decrease in populations of eight large mammal species.

This study also found that two active camps, Nduta and Nyarugusu, remain in the west sampling location. The now-closed camps, such as Mtabila-Kasulu, Mtendeli, Karago-Kakonko, Kanembwa, and Mkugwa-Kibondo, were also in the west, while Lugufu-Uvinza was in the south, and Karago-Kakonko was in the north sampling location. The majority of the camps were in the west, severely impacting the reserve, particularly through poaching.

A confidential informant noted that refugee camps are usually located near the reserve, where refugees engage in poaching and other illegal wildlife activities. Some refugees escape these camps to settle in communities adjacent to the reserve, continuing their illegal activities. Most refugees in these camps are from the DRC, Rwanda, and predominantly Burundi. With Burundi's proximity to the reserve, long-settled refugees often collaborate with newcomers to bring in illegal firearms for wildlife poaching. Some indigenous people assist the illegal immigrants, providing accommodation and facilitating their access to the reserve.

This influx has put additional strain on the reserve's natural resources and encouraged illegal wildlife activities. Since the 1950s, Tanzania has hosted refugees from Burundi, Zambia, the Democratic Republic of the Congo (DRC), Uganda, and Somalia (Msokwe, 2018; Waters, 1987) The 1994 Rwandan genocide caused an influx of refugees settled in camps in Kigoma and Kagera regions (Masalu, 2008; (Tague, 2019). Consequently, illegal immigration has increased over time in Tanzania, with impacts ranging from deforestation, poaching, firewood collection, soil erosion, pollution of groundwater, and depletion of wildlife populations in protected areas (Masalu, 2008).

Conclusion

The drivers of illegal wildlife activities are complex, encompassing factors such as subsistence needs, economic incentives, insufficient resources like fuelwood and agricultural land, high market values for wildlife products, and the influence of foreign settlers and immigrants. Despite these challenges, significant interventions have been implemented, leading to a decline in illegal wildlife activities. Efforts have included enhanced law enforcement, community engagement, and international cooperation. These interventions have helped mitigate the drivers of illegal wildlife activities, although challenges persist, particularly in addressing underlying socio-economic factors and ensuring sustainable resource management.

Recommendation

This study recommends continued collaboration between governments, communities, and conservation organizations as essential to further reducing illegal wildlife activities and protecting biodiversity in the reserve. The increased use of technology, such as drones for patrols and boats, can act as a deterrent to those considering engaging in illegal activities. Encouraging youth, who are often involved in these activities, to form groups and providing them with micro-credit loans to start small businesses could offer alternative livelihoods. Additionally, conservation education and awareness campaigns led by wildlife professionals, youth groups, and local media should target school children and all age groups within the communities. The government should also consider relocating refugee camps to areas far from protected zones in the future. Moreover, village land use planning should include the categorization of settlement, farming, and grazing areas, which is crucial for minimizing illegal wildlife activities in the reserve.

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